Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S THEORY EXAMINATION

22 June 2013

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Non-programmable calculators may be used.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) List **TWO** types of earth electrode that may be used to connect an MEN system to the mass of earth.

(2 marks)

(1) _____

(2) _____

(b) State **TWO** main functions of a ballast (choke) in a fluorescent light fitting.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(c) An alternator has 48 poles and is to feed into the MEN distribution system.

Calculate the speed of rotation of the alternator to enable it to feed into the distribution system.

(2 marks)

(turn over)

Question 1 continued

(d) A RCCB protects a 230V final subcircuit and a Class I, fixed-wired electrical appliance. The RCCB has operated (tripped).

State what has occurred to cause the RCCB to operate (trip).

(2 marks)

_____

_____

_____

_____

(e) (i) What do the initials **BJT** mean when applied to semiconductors?

(1 mark)

_____

_____

(ii) What is a **transducer**?

(1 mark)

_____

_____

_____

(f) State the main reason why it is important to consider prospective-short-circuit current when selecting a protection device for installation on the switchboard of a low voltage electrical installation.

(2 marks)

_____

_____

_____

(turn over)

Question 1 continued

(g) A low voltage domestic installation is required to have a main earthing lead.

(i) To which parts of the electrical installation are the ends of the main earthing conductor **connected**?

(1 mark)

_____

_____

(ii) Except for the parts stated in (g)(i), state:

(A) What is required to be attached at one end of the main earthing lead?

(½ mark)

_____

_____

(B) At which end of the main earthing lead is the part stated in (ii)(A) to be attached.

(½ mark)

_____

_____

(h) (i) Define the term **cut off time** as it applies an HRC fuse.

(1 mark)

_____

_____

_____

(ii) Define the term **total clearing time** as it applies an HRC fuse.

(1 mark)

_____

_____

_____

(turn over)

Question 1 continued

(i) State how a thermistor protects a three-phase induction motor when a mechanical overload occurs.

(2 marks)

_____

_____

_____

_____

_____

(j) State the formula used to determine the power consumed by:

(i) An inductive three-phase load.

(1 mark)

_____

(ii) A resistive single-phase load.

(1 mark)

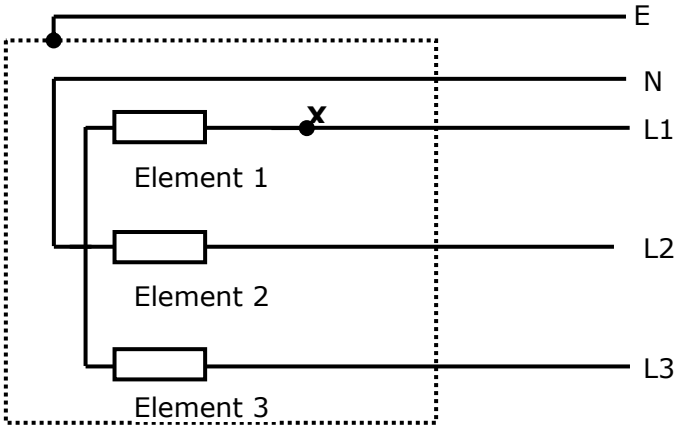
_____

(turn over)

Question 2

Introduction

This figure is a 400V, three-phase, star-connected commercial oven.



- Each element draws a current of 26.08A.
- The oven is protected by 40A HRC fuses with a fusing factor (gG Utilisation Category) of 1.5.
- The earth fault loop impedance for the oven circuit is 0.37Ω. This reading **includes** a protective earthing conductor resistance of 0.1Ω.
- An earth fault of 14.7Ω has developed between L1 and the oven frame while the oven is operating. The fault occurred at point X.

Use the information in the introduction to this question to answer parts 2(a), 2(b), 2(c) and 2(d).

(turn over)

Question 2 continued

(a) Calculate the **total current** that will flow in L1 under the fault conditions.

(4 marks)

(b) Use calculations to determine whether the fuse protecting L1 will operate.

(2 marks)

(c) Use calculations to determine the voltage that will appear on the frame of the oven under the fault conditions.

(2 marks)

(turn over)

Question 2 continued

(d) State whether or not the earth fault causes a shock hazard to the user of the oven. State a reason to support your answer.

(2 marks)

_____

_____

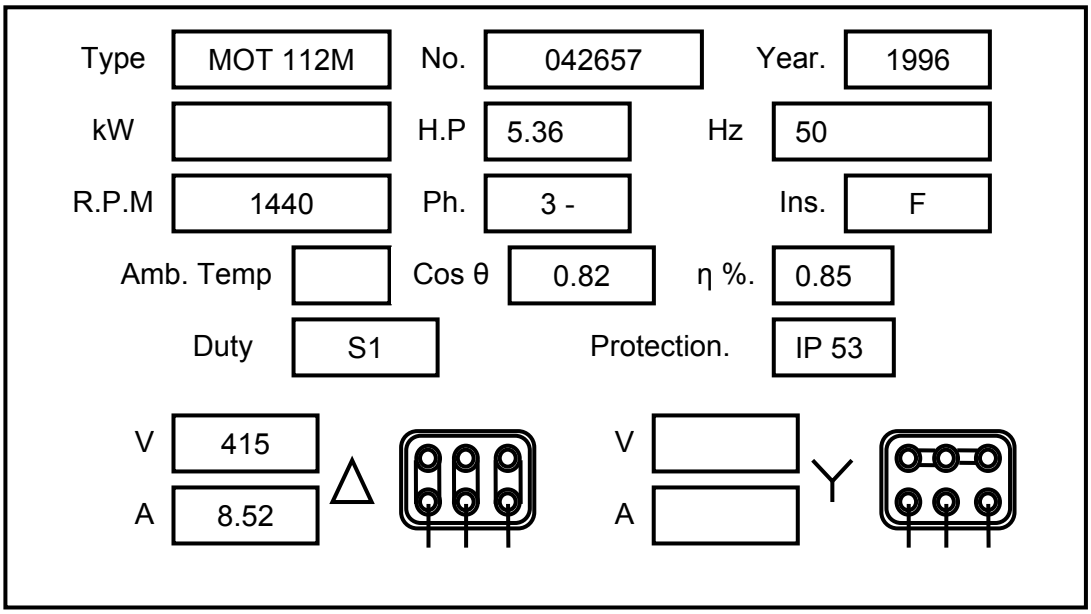
_____

_____

(turn over)

Question 3

The figure below is the nameplate of a motor.



(a) From the nameplate, state the power factor of the motor.

(½ mark)

_____

(b) Use information from the nameplate to calculate the kilowatt rating of the motor

(2 marks)

(c) Calculate the **full-load input** kilowatts of the motor

(2 marks)

(turn over)

Question 3 continued

(d) The motor has a protection rating of IP 53.

(i) What does the term **IP** mean?

(1 mark)

_____

_____

(ii) What is indicated by the **first** number?

(1 mark)

_____

_____

(iii) What is indicated by the **second** number?

(1 mark)

_____

_____

(e) What method of motor connection is indicated by this symbol?

(½ mark)

_____

(f) What method of motor connection is indicated by this symbol?

(½ mark)

_____

(turn over)

Question 3 continued

(g) There are various protection devices protecting the motor and motor final subcircuit.

Complete the following table and state the type of device that is **designed primarily** to deal with the following faults.

(1½ marks)

Type of fault	**Type of protection device**
Short circuit	_____
Over-temperature	_____
Phase polarity	_____

(turn over)

Question 4

Introduction

A three-phase 400V, 3kW induction motor in an industrial machine is controlled by a **star-delta** starter.

The motor was been removed from the machine for cleaning and checking.

The motor has been returned, and checks and tests must be carried out to ensure the motor is safe to reconnect.

Use the information in the introduction to this question to answer parts 4(a) and 4(b).

(a) The cable supplying the motor is still connected to the motor.

Describe how to test the motor and attached cables to identify the motor windings. Identify the type of instrument to be used, and state the expected test results.

(3 marks)

_____

_____

_____

_____

_____

_____

(b) The cable supplying the motor is still connected to the motor.

Two tests using test instruments need to be carried out on the motor and attached cables to ensure it is safe to connect to the electricity supply.

(i) State the first test that needs to be carried out.

(½ mark)

_____

_____

(turn over)

Question 4 continued

(ii) For each of the two tests state:

- The type of test instrument used.
- The test voltage, if applicable
- How the test is carried out.
- A test result value that will permit the motor to be returned to service.

(6½ marks)

(turn over)

Question 5

Introduction

In an office, a 40A, RCCB and 20A, MCB protect a 230V final sub-circuit that supplies:

- 6 double socket outlets supplying various electrical appliances.
- 2 fixed-wired electrical appliances supplied from permanent connection units. **When operating normally each appliance has a resistance of 8.54Ω.**

The MCB has tripped. All the plug-in electrical appliances were disconnected.

When the MCB is reset, it trips again when the supply is restored to the final subcircuit.

The MCB is not faulty and is correctly rated for the circuit. Overloading is not an issue.

The fault is in the final subcircuit or in one of the fixed-wired appliances.

Use the information in the introduction to this question to answer parts 5(a) and 5(b).

(a) What do you need to do to ensure it is safe to locate the fault?

(2 marks)

_____

_____

_____

_____

_____

_____

(turn over)

Question 5 continued

(b) All testing to locate the fault will be carried out at the switchboard.

The test instrument to be used is a multi-function test instrument with insulation resistance (with 500V and 250V ranges), resistance, voltage and temperature functions.

(i) The first test at the switchboard will determine whether or not the fault is in the final subcircuit. For this test state:

- The action taken before the testing
- The function selected on the test instrument
- The range selected on the test instrument
- How the testing is carried out
- The test result if the fault is in the final subcircuit.

(4 marks)

(turn over)

Question 5 continued

(ii) You have found that the fault **was not** located in the final subcircuit.

The second test at the switchboard will determine whether or not the fault is in one of the fixed-wired appliances. Only one appliance can be tested at a time.

For testing one appliance state:

- The action taken before the testing
- The function selected on the test instrument
- The range selected on the test instrument
- How the testing is carried out
- The test result if the fault is in an appliance.

(4 marks)

(turn over)

Question 6

(a) (i) In New Zealand, the standard distribution system has the neutral conductor connected to the earth at the main switchboard on all low voltage installations. What name is given to this type of system?

(2 marks)

_____

(ii) State **TWO** **technical** reasons why the neutral conductor is earthed.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

_____

(b) In an electrical installation the **rupturing capacity** of an MCB on the switchboard is **under-rated** for the fault level of the installation.

State **TWO** situations that could occur if a short-circuit fault occurs on the final subcircuit the MCB protects.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(turn over)

Question 6 continued

(c) In an electrical installation the **rupturing capacity** of an MCB on the switchboard is **over-rated** for the fault level of the installation.

State **TWO** situations that could occur if a short-circuit fault occurs on the final subcircuit that the MCB protects.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(d) A 250kVA, 400V 3 phase transformer has a 5% impedance.

Calculate the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.

(2 marks)

(turn over)

Question 7

(a) **Introduction**

A 150 kVA, three-phase, delta-star-connected step-down transformer has a phase- turns ratio of 287 to 1.

The primary is connected to a 66 kV, three-phase supply.

The transformer is fully loaded.

Use the information in the introduction to this question to answer parts 7(a)(i), 7(a)(ii), 7(a)(iii) and 7(a)(iv).

(i) Calculate the **secondary phase** voltage.

(2 marks)

(ii) Calculate the **secondary line** voltage.

(2 marks)

(turn over)

Question 7 continued

(iii) Calculate the **primary line** current.

(2 marks)

(iv) Calculate the **secondary line** current.

(2 marks)

(b) State the **TWO** conditions that occur when the secondary circuit of a CT is opened when the CT is live.

(2 marks)

(1) _____

_____

(2) _____

_____

(turn over)

Question 8

(a) (i) Calculate a typical fusing current of a 20A **gG** rated HRC fuse.

(1 mark)

(ii) Calculate a typical fusing current of a 20A **gM** rated HRC fuse.

(1 mark)

(b) Describe what occurs in an electrical installation when a fault occurs and there is **correct discrimination** between protective devices.

(2 marks)

_____

_____

_____

_____

(c) State what is meant by the term **current rating** as it applies to an HRC fuse?

(1 mark)

_____

_____

_____

(turn over)

Question 8 continued

(d) From the chart below select the minimum size fuse that will provide discrimination for a 100A fuse, if that fuse is the "downstream" fuse (that is, closest to the load). Provide an explanation for your selection.

Current Rating Amps	Pre Arcing time (I^2x10^3)	Total Clearing time (I^2x10^3)
80	14	40
100	17	60
125	25	85
160	62	160
200	105	250
250	200	550

(3 marks)

_____

_____

_____

_____

_____

(e) You have carried out an earth fault loop impedance test on a domestic installation and the test indicates that the fault level is 1.2 kA. On the switchboard there are three rewireable fuses.

(i) The rewireable fuses must be replaced with MCBs. State **ONE** reason why the rewireable fuses need replacing.

(1 mark)

_____

_____

(ii) The rewireable fuses must be replaced with MCBs. State **ONE** reason why MCBs are used to replace the rewireable.

(1 mark)

_____

_____

(turn over)

Question 9

(a) You are testing the integrity of the insulation of a 230V, Class I, electrical appliance that has been repaired. The appliance has semi-conductor devices used in its internal circuitry. It is impractical to disconnect the semi-conductors.

(i) To test the integrity of the insulation you have an **insulation resistance tester with 100V d.c. and 250V d.c ranges**.

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service.

(2½ marks)

(ii) To test the integrity of the insulation you have an **insulation resistance tester with 500V d.c. and 1000V d.c ranges**.

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service.

(3 marks)

(turn over)

Question 9 continued

(iii) To test the integrity of the insulation you have a **clip-on (clamp) ammeter with mA ranges**.

Describe how you would test the integrity of the insulation of the appliance using **this** test instrument. Include:

- Whether the appliance needs to be live.
- A test result that permits the appliance to be returned to service.

(2 marks)

_____

_____

_____

_____

_____

_____

(b) You have repaired the electric motor and flexible supply cord of a 230V, Class I, plug-in dishwasher. You need to carry out an earth continuity (protective earthing conductor) test.

(i) What instrument should be used to make the earth continuity test?

(½ mark)

_____

(ii) Briefly describe how you would carry out this test.

(1 mark)

_____

_____

_____

_____

(iii) State test result that permits the dishwasher to be returned to service.

(1 mark)

_____

For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only		
Questions Answered	**Marks**	
1		
2		
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6		
7		
8		
9		
TOTAL		